In This Issue

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"Tell me what you eat, and I will tell what you are." This quote, made famous by Brillat-Savarin in his seminal essay about gastronomy, summarizes the central role that food has played in the history of mankind. Food catalyzes reunion, celebration, and social identification. Conversely, the pursuit of food is also a driver of migrations and wars. Malnourishment still plagues underdeveloped areas across the globe, and the technological advancements needed to ensure the resources to feed a growing global population remain unmet goals. Paradoxically, overabundances of foodstuffs and dietary changes in the other areas of the contemporary world have produced changes in human biology that have triggered national health crises. The multifaceted ways in which food factors into biological, social, and political issues seem to only be getting more complex. This special issue, The Biology of Food, explores the science behind food, nutrition, and metabolism. Like any great menu, it offers plenty of options that we hope will first tantalize and then satisfy each individual's palate. The making of this issue has relied upon a special ingredient: the involvement of many dedicated authors and reviewers across all fields of biology, and we would like to thank them for their time, effort, and unique insights. We invite you to join us at the table. Bon appétit!

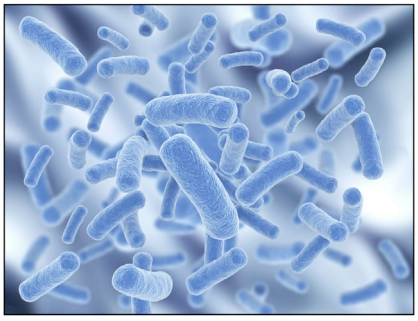
Ingredients for a Great Meal

Chefs and scientists share the desire to experiment, combine "ingredients" with precision, create, and perfect techniques to achieve outstanding results. In the Commentary that opens this issue (pp. 1–4), Pia Sörensen and Michael Brenner deconstruct molecular gastronomy, unraveling the biophysics behind the multitude of shapes, textures, and flavors that ingredients, as simple as an egg, can adopt. Benjamin Wolfe and Rachel Dutton delve deep into the world of fermentation—a microbial process that humans have harnessed for preservation and flavor development for over a thousand years. In this Review (pp. 49–56), they elaborate on how studying microbes that produce different qualities in cheese rind or kimchi provides opportunities to dissect mechanisms and general principles of microbial community formation.

Providing food security to an increasingly larger global population bathes food production in a sobering light. The expanding gap between demand and yield of primary foodstuffs highlights the potential for food shortages by 2050. In his Review (pp. 56–66), Stephen Long discusses emerging approaches that can improve crop photosynthetic efficiency to achieve a future with nutritious food for all.

A Balance of Nutrients and Flavor

Dietary balance is fundamental to health. What this "balance" represents and how it can be achieved are not so clear. A provocative series of Essays underscores research and technological breakthroughs needed to understand the complex effects of nutrition in human physiology and to combat malnourishment as well as overnutrition. Charles Zuker (Essay, pp. 9–11) discusses how the brain is wired to detect energy-rich food sources. Danny Ben-Zvi and Douglas Melton (Essay, pp. 12–17) take technology one step further, envisioning in vitro human stem-cell-derived digestive systems populated with gut microbiota to model disease and study nutrition. Complementing this Essay, the development of endocrine cells in the gastrointestinal system, and their roles in digestion and nutrient homeostasis, is beautifully illustrated in the Snapshot by Patrick McGrath and Jim Wells (pp. 176). In the final Essay, Stephen Simpson and his colleagues (pp. 18–23) present a different approach to the problem of dietary balance, framed from the perspective of nutritional ecology, in which integration of the interactive effects of multiple nutrients is key.



If dietary balance is indeed crucial for a healthy life, why do so many people prefer chocolate over broccoli? How do we make conscious decisions about what to eat? On pp. 24–35, Charles Spence provides a Perspective on the complex multisensory interactions that give rise to the flavor experiences we all know and love. He highlights that our perception of food relies on the integration of cues from all of the human senses and reveals how chefs and the food industry are taking the latest scientific findings on-board in their food design.

Matching Diet to Environment

For organisms to coordinate their growth and development with nutrient availability, they must be able to sense nutrient levels in their environment. David Sabatini and colleagues approach this question on the cellular level. In their Review (pp. 67), they discuss how these sensing mechanisms reflect the nutrient requirements of specific species and how they have adapted to support the emergence of multicellularity in eukaryotes. At the organismal level, a network of biological pacemakers known as the circadian clock directs and maintains proper rhythms in endocrine and metabolic pathways

required for organism homeostasis. On pp. 84–92, Gad Asher and Paolo Sassone-Corsi review the biological basis for clock adaptation to environmental changes, such as daily light-dark cycles and rhythmic food intake. Nutritional challenges reprogram the clock, while time-specific food intake deeply impacts physiology, calling for attention on the beneficial effects of chrono-nutrition.

Not only does an individual's environment influence their own metabolism, but in some cases the environment experienced by their parents also contributes to their risk of metabolic disease. Rebecca Simmons and Oliver Rando's Review (pp. 93–105) gathers evidence for the effects of parental diet on the offspring's metabolic phenotype in mammals and provides a current survey of mechanisms underlying these effects. As organisms develop and grow, they acquire companions for a lifetime. The microbiota, the collection of all microbes in symbiotic tête-à-tête with a host, is assembled early in life. Jeff Gordon and colleagues (Perspective, pp. 36–48) introduce the concept that microbiota immaturity is causally related to the pathogenesis of undernutrition and its lingering sequelae. They make a case for integrating this knowledge into efforts to develop new food preparations that sustain a healthy microbiota in children and mothers grappling with undernutrition. Understanding the configuration of microbiota in children representing diverse geographic backgrounds, cultural traditions, and states of health will be also required to assess the effect of the changes in eating practices brought about by globalization.

On the flip side, reduced food intake whilst avoiding malnutrition can ameliorate the effects of aging and aging-related diseases in model organisms and mammals. The effects of dietary restriction in longevity and healthspan are the focus of Luigi Fontana and Linda Partridge's Review (pp. 106–118).

Deconstructing Obesity

The global rise in the prevalence of obesity and co-morbidities such as type 2 diabetes, cardiovascular ailments, and cancer now represents a major public health concern. While the pathophysiology of such diseases is complex and multifactorial, the biological response to unbalanced consumption of palatable food and reduced energy expenditure is at the core of the problem. In "Hunger Genes: Pathways to Obesity" (Review, pp. 119–132), Agatha A. van der Klaauw and Sadaf Farooqi outline the genetics underlying the variability of the metabolic response to food in humans. The genetic framework will be valuable for the identification of effective mechanisms to prevent and treat obesity in susceptible individuals. On pp. 133–145 (Review), Joel Elmquist and his colleagues tackle obesity from the neuroscience perspective. They provide an up-to-date view on the neural circuits controlling energy balance and glucose homeostasis and their potential for pharmacological and surgical interventions. At last, Jonathan Brestoff and David Artis bridge the gap between immunology and obesity, discussing the emerging concepts in immune regulation of metabolism (Review, pp. 146–160). These three reviews offer a multidisciplinary understanding of metabolic diseases.

The special issue wraps up with two very special treats. On pp. 157–168, Nobel laureates Mike Brown and Joe Goldstein look at the past, present, and future of cholesterol research in the review "A Century of Cholesterol and Coronaries: From Plaques to Genes to Statins". Finally, Zhu Chen, Juleen Zierath, C. Ronald Kahn, Bruce Spiegelman, Stephen O'Rahilly, and Jens Brüning, all active leaders in the metabolism field, provide valuable solutions at different levels to stop the obesity epidemic and to improve health and well-being of people (pp. 173–174, Voices).

We hope that this special issue will connect researchers working in fields with different flavors and inspire scientists to pose new questions and pursue answers to the many unsolved mysteries behind the biology of food.

João Monteiro